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Fiber Lasers for Fusion Laser Oscillator Systems

Russell B. Wilcox and Donald F. Browning
Lawrence Livermore National Laboratory
M/S L-490
P.O. Box 808
Livermore, CA 94551-0808
(510) 423-1343 (phone)
(510) 422-7748 (fax)
wilcox2@llnl.gov

Please schedule this paper for oral presentation.

Abstract:

A recent design for fusion laser pulse forming uses low power fiber communications technology to create an optical pulse, and a low noise, high gain preamplifier before injection into the power amplifier system. We are using this concept for the front end of the National Ignition Facility (NIF) where there will be 192 such systems in parallel. Four tunable, single mode fiber oscillators will each be amplified by fiber amplifiers and split into 48 outputs to supply integrated optic amplitude modulators. These modulators form the desired shaped pulses for each beam of NIF.

Fiber lasers offer several advantages, including low noise, high gain, ease of coupling into other fiber optic devices, and efficient use of tunable, low gain materials such as glass. Fiber lasers are used commercially in communications systems at 1.3 and 1.5 microns, but NIF will operate at 1.052, 1.053, 1.054, and 1.055 micron wavelengths, requiring different gain media and fiber component design. Also, the NIF system operates in a pulsed regime, in contrast to the CW operation in most communications applications. We must therefore develop special fiber laser and amplifier components for our application.

In other applications, ytterbium-doped silica has been shown to be capable of tunable and Q-switched operation in an oscillator, and of high gain and power in an amplifier. Silica is a desirable host due to its good mechanical characteristics and the possibility of fusion splicing to other fibers. We have chosen to focus on this material as the gain medium in our experiments.

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We have demonstrated tunable operation of fiber oscillators, and pulsed amplification in fiber amplifiers, as part of the development of the oscillator system for NIF. When pumped with a 150mW, single transverse mode laser diode at 860nm, a Yb:silica single mode fiber exhibits small signal gain of over 1000. A grating tuned, Yb:silica oscillator tunes over tens of nanometers, easily producing the required four wavelengths. Using this oscillator, we have measured the gain and saturation characteristics of a Yb:silica amplifier at different wavelengths, using this data to help design an optimized fiber amplifier. Ongoing work includes Q-switching the oscillator, and operating it in a single longitudinal mode.